THE UPPER PALAEOZOIC ROCKS OF TASMANIA.

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(Two Text-figures.)

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At the suggestion of Dr. A. N. Lewis, of Hobart, a visit was made to Tasmania during March and April, 1937, in order to examine critically the most important sections of Upper Palaeozoic rocks so that comparisons might be made at a later stage between them and corresponding sections on the mainland of Australia. This paper presents a reorganized account of the Upper Palaeozoic succession for Tasmania. It has been compiled after a careful field examination of many of the sections and a study of the literature.

It has been necessary to curtail any criticisms of earlier works owing to the length of this paper and in order to avoid confusion. The author does not agree with any interpretations previously put forward, and has attempted to subdivide the sequence in a manner which will permit more exact reference to the occurrences by future workers.

Unfortunately, it has been found imperative to reject the serial names used by Johnston (1888) and his successors, as there does not seem to be sufficient data available to uphold the implied correlation with the Hunter River (N.S.W.) Kamilaroi sequence. The same terminology as that used in New South Wales has been used in Tasmania up to the present time.

Owing to recent research on Kamilaroi palaeontology little reliance is placed on fossils whose ranges were once regarded as limited to certain zones within the system. Hence, in a fragmental record such as the Tasmanian one, it is rarely that the correct stratigraphical position of any bed can be ascertained. Similarly, it is difficult to determine either the positions or duration of any of the non-sequences, many of which must have occurred.

This paper will be destructive in its main theme, which is to break down the old system of nomenclature, but it is hoped that out of the ruins will arise a more satisfactory classification than that which has been used in the past.

Previous Literature.

The most comprehensive description of the Tasmanian Upper Palaeozoic rocks is that of R. M. Johnston (1888). He placed all the beds in the Carboniferous System and divided them into similar series to those occurring in the Hunter Valley, N.S.W., and gave these series exactly the same names, viz. Lower Marine Series, Greta Coal Measures, Upper Marine Series. He considered that no representatives of the Newcastle Coal Measures (N.S.W.), which he placed doubtfully in the Permian System, had been discovered in Tasmania.

Field-work in Upper Palaeozoic areas was carried on, notably by W. H. Twelvetrees (1903, 1912, 1915*a*, 1915*b*, 1918), Loftus Hills (1913, 1914, 1921), and

A. M. Reid (1919, 1922) prior to the publication in 1922 of "The Coal Resources of Tasmania" by the Tasmanian Geological Survey. In this publication all the Upper Palaeozoic beds were included in the Permo-Carboniferous System, but essentially the same subdivisions which had been adopted by Johnston were retained. In addition, an Upper Coal Measure series of Tomago or Newcastle age was introduced in order to include the Cygnet and Mount Pelion Coal Measures and some doubtful coal beds at Preolenna.

Careful geological mapping was carried on for some years by P. B. Nye, Government Geologist of Tasmania, chiefly in connection with the question of underground water and limestone resources (1921–1926).

Recently A. N. Lewis has made some notable observations, the most important being his recognition of a second glacial horizon which occurs high in the sequence. As Dr. Lewis's work on the Hobart District is not yet complete, he has kindly permitted me to incorporate some of his tentative conclusions in this paper.

Nomenclature.

There is still much disagreement among geologists as to the limits of the Permian System. Some desire to include in it all or part of the Uralian beds, while others regard it as commencing at the base of the Artinskian. In Australia, however, there is general agreement that there is a unity about all the beds from the base of the Lochinvar Glacial Stage to the base of the Triassic System. The fauna is uniform and characteristic throughout and cannot be confused in any way with that of the underlying Carboniferous System. Very few forms are common to both. The Glossopteris-Gangamopteris flora is characteristic also.

Australian geologists differ principally with regard to the nomenclature of the system. One group, supported strongly by the late W. S. Dun, A. B. Walkom and more recently by H. Raggatt and H. Fletcher (1937), has insisted on the use of the name of "Permian" for the sequence because, whatever arguments might be brought forward by extra-Australian geologists, the division between Carboniferous and Permian rocks, if placed higher in the sequence than the base of the Lochinvar Glacial Stage, would be artificial in the extreme and unsupported by palaeontological or lithological evidence.

The late Professor Sir T. W. E. David, while recognizing the unity of the Australian sequence, introduced the name "Kamilaroi" to replace "Permo-Carboniferous", and thereby avoided the necessity for committing himself with regard to the limits of the Permian and Carboniferous beds abroad.

While the introduction of a new term is not altogether desirable, it is preferable to "Permo-Carboniferous" and is a useful one until the controversy is settled. Should it be agreed to include in the Permian System all beds from the base of the Dwyka (South Africa), Talchir (India) and Lochinvar (N.S.W.) glacial beds up to the base of the Triassic System, the use of the name "Kamilaroi" will become unnecessary.

As the writer is opposed to the correlation of any part of the Kamilaroi sequence with the Carboniferous System, it was only after much deliberation than he decided to follow the more conciliatory course and use "Kamilaroi" instead of "Permian" in this paper.

Structure and Distribution.

The Kamilaroi sediments in Tasmania rest unconformably upon folded older Palaeozoic or Pre-Cambrian strata or upon granites which are intrusive into

Silurian and earlier sedimentary rocks. No Carboniferous or Devonian deposits have been found. The overlying beds consist of Triassic or Jurassic fresh-water sediments which are disconformable and separated by a hiatus of considerable duration. This interval marks the withdrawal of the Kamilaroi seas and the commencement of terrestrial conditions which prevailed throughout the Mesozoic Era.

The outcrops are well distributed throughout the Island, being found in outliers or in downfaulted blocks to the north and west. In the southern districts they outcrop round the flanks of the highlands where they are protected from erosion by dolerite sills. The dolerite was intruded into Kamilaroi, Triassic and Jurassic strata, probably at the close of the Jurassic sedimentation.

No great folding movements have affected the Upper Palaeozoic or Mesozoic rocks, but block-faulting at the close of the Tertiary Era has given to the beds dips amounting to as much as 10° or, locally, a higher angle. The dips correspond to the tilt of the surface of the elevated or depressed blocks on which they rest. In general, however, the beds are horizontal or nearly so, and such a disposition may be assumed for the purpose of stratigraphical discussion. Irregularities occur only in proximity to the major faults and close to dolerite intrusions.

The outcrops of Kamilaroi rocks are indicated on the accompanying map, which is based on the "Geological Map of Tasmania" published by the Tasmanian Department of Mines in 1928.

Stratigraphy.

Sedimentation during the Kamilaroi Period took place on a continental shelf including most of Tasmania. Under such conditions of relative stability there was little opportunity for the accumulation of great thicknesses of sediment. Field evidence points to considerable oscillations in sea-level, resulting in an intermittent deposition with constant redistribution of the more recently deposited sediments.

A number of important aspects of sedimentation were dealt with by Joseph Barrell (1917). Although his conclusions cannot be discussed here, they have particular application to the problems met with in an examination of the Tasmanian sedimentary record. This record is incomplete, as will be noted from the descriptions of the main sections which follow.

In this paper the Kamilaroi System in Tasmania is divided into stages. No definite nomenclature has been applied to these stages in the past, although several of them have been included in the "Upper Marine" or "Lower Marine" Series or "Coal Measures". As it does not appear likely that any one series is universal throughout Tasmania, and in view of the difficulties arising through attempts at correlation from one area to another, none of these stages have been grouped under any serial name. It is quite probable that some sections such as, say, those in the St. Mary's District, may contain stages which are not represented at all in the Hobart or Mersey sequences.

The Kamilaroi rocks may be discussed conveniently in four areal divisions as follows:

1. Southern Division, including i, Hobart District; ii, Maria Island; iii, Eaglehawk Neck; iv, Cape Paul Lamanon; v, sundry localities.

2. Northern Division, including i, Mersey District; ii, Lilydale and Karoola; iii, Beaconsfield; iv, Western Tiers; v, Wynyard and Preolenna.

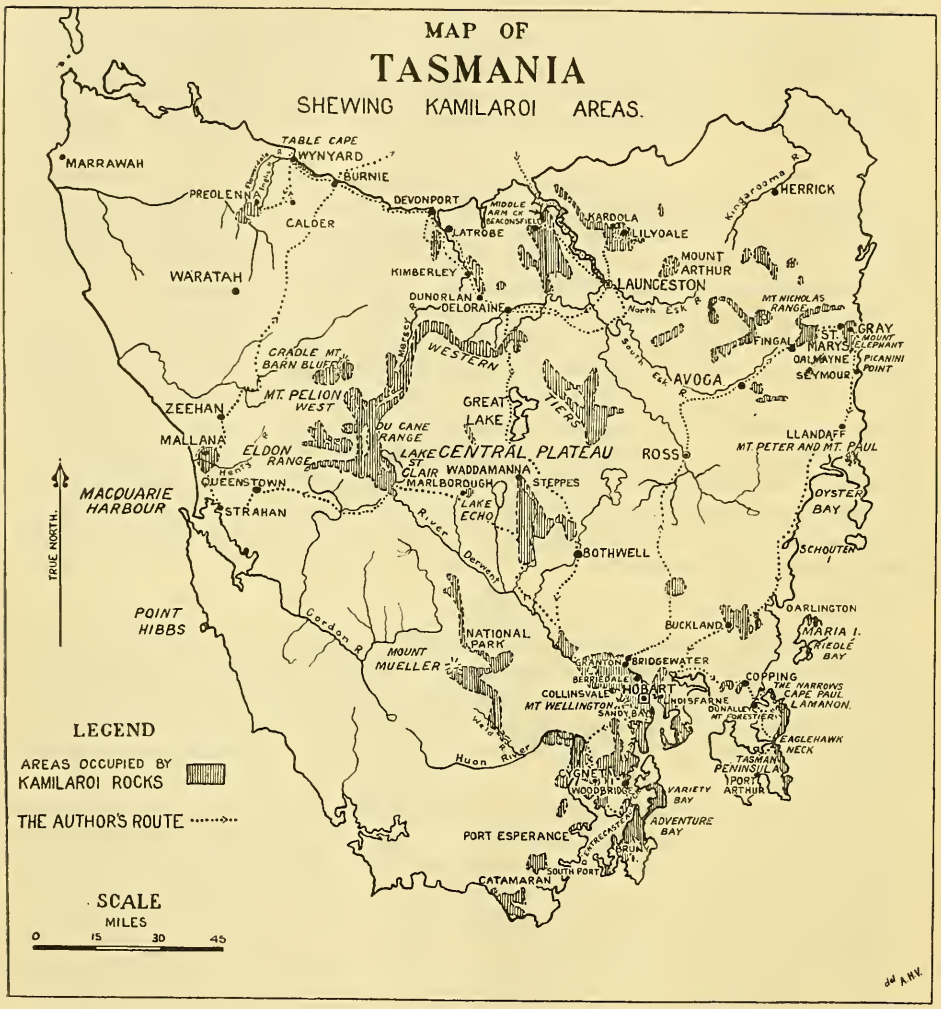

Fig. 1.

3. Western Division, including i, Mount Pelion, Barn Bluff, Cradle Mountain, Eldon and Du Cane Ranges; ii, Henty River; iii, Central Plateau; iv, Point Hibbs.

4. Eastern Division, including i, St. Mary's District; ii, Avoca, Fingal, etc.; iii, Dalmayne; iv, Picanini Creek; v, Seymour; vi, Llandaff; vii, Mount Peter and Mount Paul.

1. SOUTHERN DIVISION.

The most complete sequence of Kamilaroi rocks in Tasmania occurs in this division. Unfortunately, no section has been found in which all of the stages are fully represented, and their relative positions have been deduced from the examination of a number of sections. The sequence given below appears to be reasonably correct, but subsequent work may demand minor alterations.

The following summary will convey some idea of the positions of the stages:

	Approximate Thickness (feet).
TRIASSIC SYSTEM.	
Hiatus and disconformity.	
KAMILAROI SYSTEM.	
(*g*) Cygnet Coal Measures. Fresh-water carbonaceous shales containing coal seams. Plant remains include *Gangamopteris spatulata, Gangamopteris obliqua, Glossopteris Browniana*, var. *praecursor, Vertebraria australis.* ..	200
(*f*) Lindisfarne Stage. Fine-grained grey siliceous mudstones weathering to a yellow colour. They are typically unfossiliferous, but in some areas contain bands of marine fossils.	700
(*e*) Woodbridge Glacial Stage. Marine calcareous sandstones and mudstones, occasionally fossiliferous and containing erratics of granite, quartzite, etc. Occasional limestone bands are present.	800
(*d*) Grange Stage. Typically fine-grained marine fossiliferous mudstones, bryozoan limestones and occasional sandstones.	400
(*c*) Porter's Hill Stage. A fresh-water development of sandstones and mudstones only found, up to the present, at Porter's Hill. Fragments of *Gangamopteris* and other plants are recorded. Here is also an abundance of a small crustacean, *Cythere tasmanica.*	50
(*b*) Granton Stage. Marine sandstones, grey mudstones, calcareous mudstones and dark-grey limestones containing a magnificent suite of fossils, notably *Eurydesma cordatum* and *E. hobartense*, which occur in the lower beds. Johnston (1888, 1900-01) recognized four palaeontological zones at Maria Island: (4) Crinoidal Zone, (3) Productus Zone, (2) Fenestella Zone, (1) Eurydesma Zone. These do not appear to be definitely recognizable through the Hobart District.	800
(*a*) Basal Glacial Stage. Tillites, conglomeratic mudstones with a variety of pebbles, including huge blocks of granites, schists, gneisses, slates and quartzites.	400
Hiatus and unconformity.	
OLDER PALAEOZOIC ROCKS AND GRANITES.	

The thicknesses given above are, in most cases, rough estimates only, as it is rarely that the limits of a stage can be defined. Time breaks occur, but it is impossible to determine where these are in the sequence.

i. *Hobart District.*

Kamilaroi rocks outcrop over a large part of the country between the National Park and Catamaran and also on Bruny Island. The succession is interrupted in a great many places by intrusive dolerite and also by Tertiary block-faulting. Such interruptions have made the elucidation of the sequence a most difficult matter. Dr. A. N. Lewis is engaged at present in mapping the area in detail. The following observations were made under his direction and the conclusions arrived at are largely the result of his investigations.

(g) Cygnet Coal Measures.

These beds outcrop on Bruny Island, Mount Cygnet, Southport and elsewhere in the neighbourhood of the D'Entrecasteaux Channel. Two main coal-seams and indications of others were found in the Mount Cygnet area. The upper one is from 15 inches to 3 feet thick, and the other, 20 feet lower, is about 1 foot thick. *Gangamopteris spatulata, Gangamopteris obliqua, Glossopteris Browniana* var. *praecursor*, and *Vertebraria australis* have been recorded from the locality.

Johnston (1888) described sections of these rocks at Adventure Bay and Ida Bay on Bruny Island. Here they overlie beds which appear to belong to the Lindisfarne Stage, beneath which is the Woodbridge Glacial Stage. He correlated them with the Cygnet Coal Measures, but, probably on account of his belief that the glacial beds were at the base of the system, placed them in the Lower Coal Measures. He recorded similar plant fossils to those noted above.

The beds associated with the coal-seams in this stage are carbonaceous shales and laminated sandstones sometimes showing ripple-marks.

(*f*) *Lindisfarne Stage.*

The characteristic rocks of this stage are grey mudstones which weather to a buff colour and are quite distinctive in appearance. They are generally unfossiliferous and are known as the "barren yellow mud-stones". Occasional bands of marine fossils do occur at Bruny Island, Eaglehawk Neck and elsewhere.

Immediately underlying Triassic sandstones near Sky Farm on Mount Faulkner, 700 feet of the typical unfossiliferous mudstones were measured. A prominent band of sandstone 15 feet thick marks the base of the stage in this locality.

It is probable that, in some areas, pre-Triassic erosion has removed the topmost beds of the Lindisfarne Stage together with the Cygnet Coal Measures if these had been developed. Such an occurrence would explain the variations in the thickness of the Lindisfarne Stage, which appears to be persistent throughout southern Tasmania at least.

(*e*) *Woodbridge Glacial Stage.*

These beds consist of calcareous sandstones and mudstones with occasional bands of bryozoan limestones. They form part of a continuous marine sequence and their limits are not always well defined. The main criterion for this glacial stage is the presence of angular fragments of quartzites, cherts, granites, porphyries, schists, etc. These glacial erratics are scattered through the calcareous sandstones and mudstones. Their irregular distribution is well shown by the rock platforms at Lindisfarne, Port Esperance and Bruny Island and by road cuttings at Little Peppermint Bay.

Glacial deposits have not been identified in all the sections examined, but this is not surprising, because the distribution of such rock-fragments is sporadic and, in their absence, the beds cannot be separated from those belonging to the underlying Grange Stage.

All the above-mentioned glacial beds had been included by Johnston (1888, etc.) and his successors in the Basal Glacial Stage on the assumption that there was only one glacial horizon in the sequence. In 1893 a drill hole sunk near the shore at South Port through shales and sandstones entered the glacial conglomerate at 500 feet and continued through pebbly sandstones with marine shells to 612 feet. This evidence that these glacial beds were not basal and the observations made at Little Peppermint Bay by Professor E. G. Hogg (1900–01) passed unnoticed until 1924, when Dr. A. N. Lewis found that marine sediments underlie a definite glacial horizon at Cape Paul Lamanon (Lewis, 1924). Following up this work, Lewis was able to demonstrate clearly (1937 and verbal communications) that all the Hobart glacial deposits occupied a high position in the sequence. This important discovery has removed many anomalies which arose out of the earlier interpretations.

(*d*) *Grange Stage.*

These beds are typically fine-grained mudstones and bryozoan limestones. They contain an abundance of marine fossils, notably brachiopods and bryozoans. The most characteristic form is *Wyndhamia dalwoodensis*, which is especially represented by beds several feet in thickness composed almost entirely of its remains. Other beds are more prolific in bryozoa or *Spirifera*.

The type locality for the stage is the Grange Quarry near Hobart. Intruding dolerite has hardened the mudstone, giving rise to a light-green cherty rock from which particularly good moulds showing the internal structure of the brachiopods may be obtained.

At Sandy Bay the base of the Grange Stage is determined by the Porter's Hill fresh-water beds, above which there is a well-marked change in the nature of the sedimentation. In other areas, however, these beds have not been recognized and the Grange Stage passes downwards into the Granton Stage without any apparent break.

(*c*) *Porter's Hill Stage.*

The beds referred to this stage outcrop at Porter's Hill near Sandy Bay, and have been given undue prominence by previous workers. They have been laid down under brackish or fresh-water conditions and are probably local in their development. The rocks are rhythmically bedded sandstones and mudstones containing fragmentary plant remains, among which *Gangamopteris* has been recognized (Johnston, 1888). A minute crustacean, *Cythere tasmanica*, is present. The beds pass downwards into fossiliferous marine strata possessing the same rhythmical characteristics. These marine rocks are included in the Granton Stage.

(*b*) *Granton Stage.*

As it is not possible at present to determine the upward limit of the Granton Stage except at Porter's Hill, it has been decided, tentatively, to fix an arbitrary division between it and the Grange Stage. The upward limit of the Granton Stage, then, may be taken as the topmost bed in the calcareous mudstone and limestone suite of rocks which are grouped under the name of the Berriedale Limestone. This is a well-marked datum horizon in the Hobart District. It is probable, but not definitely proven, that the Porter's Hill beds would occur stratigraphically slightly above this point, thus making the richly fossiliferous beds at the Grange Quarry correspond with those in the Mount Faulkner section between the Berriedale Limestone and the Lindisfarne Stage.

The most important horizon in the Granton Stage is the Berriedale Limestone, which may be traced for some miles round the Derwent River from Collinsvale, through Granton and Bridgewater. It is a fine-grained, greyish-blue rock, occurring in beds which are from 12 to 30 inches in width and separated by thin bands of calcareous shale 3 to 8 inches thick. Calcareous mudstones and shales occur above and below, and are most prolific in their fossil content. The whole calcareous unit aggregates 250 to 350 feet in thickness. Some bands of rock are composed almost entirely of the remains of bryozoa. Others are full of brachiopods and lamellibranchs.

Below this limestone are several hundred feet of sandstones and mudstones, with occasional bands of limestone. Marine fossils occur throughout, but not in such great abundance as in the upper beds. One of the lowest units in the

sequence, a thin band of lamellibranch limestone containing numerous specimens of *Eurydesma cordatum*, was found in cuttings on the Glen Lusk road not far from its junction with the Collinsvale road. The large numbers of this form present indicate that the beds form a *Eurydesma* horizon and hence occupy a low position in the Kamilaroi sequence. Faults terminate the section, and rocks stratigraphically lower than these have not been found in the vicinity of Hobart.

(*a*) *Basal Glacial Stage.*

Beds belonging to this stage do not occur above sea-level near Hobart, but they outcrop about 40 miles to the west. In the valley of the Weld River about 15 miles from its junction with the Huon, 300 feet of conglomerates overlie tillites and are followed by marine fossiliferous mudstones (Lewis, 1923). The conglomerates are coarse and regular, consisting of a hard yellowish matrix cementing together quartzite pebbles about the size of a cricket ball. These conglomerates are provisionally included in the Basal Glacial Stage, but may be a shallow-water facies in the Granton Stage.

Beneath the conglomerates is a tillite which, at the Weld River, contains a large proportion of red-granite boulders and pebbles. Further north, at Mount Mueller, these granites are absent and the rock fragments consist largely of grey quartzites, quartz, slate and mica-schist. Lewis found numerous scratched pebbles in the tillite, further demonstrating its glacial origin. The beds rest unconformably upon Cambrian quartzites.

ii. *Maria Island.*

The Kamilaroi section at Darlington was described by R. M. Johnston (1888, 1892, 1900) and is famed for its *Eurydesma* beds and glacial deposits. Lewis (verbal communications) has examined a number of other sections over the island and considers that the best occurs at Reidle Bay, seven miles south of Darlington. Here the glacial beds rest on the pre-Kamilaroi platform and are followed by fossiliferous limestones and "barren yellow mudstones". Ross Sandstone belonging to the Mesozoic Group follows the "barren yellow mudstones" at Darlington.

Pending detailed investigation, we may assume that representatives of the Lindisfarne and Woodbridge Glacial Stages overlie the combined Grange and Granton Stages.

The succession may be expressed as follows:

	Thickness (feet).
TRIASSIC SYSTEM.	
Hiatus and disconformity.	
KAMILAROI SYSTEM.	
(*c*) Lindisfarne and Woodbridge Glacial Stages	450
(*b*) Grange and Granton Stages (described by Johnston).	
4. Crinoidal Zone.	
Limestones consisting chiefly of crinoid remains in beds from 6 inches to 4 feet thick separated by thin shaly partings. Bands and masses of chalcedony occur.	320
3. Productus Zone.	
Blue limestone in beds 6 inches to 4 feet thick separated by beds of calcareous shale and mudstone, amounting probably to nearly half the bulk of the beds. Small pebbles not uncommon.	30
Shaly limestones very rich in *Spirifer* and *Productus*.	45
2. Fenestella Zone.	
Thin band of hard rock resembling tuff underlain by mudstones very rich in bryozoa.	125

	Thickness (feet).
1. Eurydesma Zone.	
Thick limestone bed almost entirely made up of shells of *Eurydesma cordatum* but containing a great deal of sand and large stones. ..	40
Calcareous shales and limestones.	36
(*a*) Basal Glacial Stage.	
Tillites, some of which Lewis (1937) suggests are land moraines; conglomerates consisting of boulders of slate, sandstone and granite cemented together by limestone; conglomeratic mudstones. .. .. More than	100
Hiatus and unconformity.	
Granite and Older Palaeozoic Quartzites.	

iii. *Eaglehawk Neck.*

From 600 to 800 feet of mudstones and sandstones belonging to the Lindisfarne Stage underlie Mesozoic Sandstones just north of Eaglehawk Neck. They contain several horizons of marine fossils. The beds pass downwards into the Woodbridge Glacial Stage, the topmost beds of which are exposed at the Blowhole and Tessellated Pavement.

iv. *Cape Paul Lamanon.*

Erosion has removed the Mesozoic beds and most of the Lindisfarne Stage. The Woodbridge Glacial Stage is well exposed in the cliff sections and on rock platforms between the Narrows and Cape Paul Lamanon. The thickness is estimated by Lewis (1924) to be at least 800 feet. Erratics of granite, quartzite, schist and slate are present, and marine fossils are scattered throughout the beds.

Peculiar structures referred to by the author (Voisey, 1934) as "arrow-head markings" occur in this stage and were observed also at Mount Wellington. No satisfactory explanation as to their origin has been put forward.

The Grange Stage consists of mudstones and limestones, some bands of which are made up almost entirely of brachiopods or bryozoa. *Spirifer tasmaniensis* is particularly common, while *Wyndhamia*, *Fenestella* and *Stenopora* zones are extraordinarily well developed.

Intrusive dolerite terminates the section.

v. *Sundry Localities.*

Kamilaroi rocks have been recorded from Port Arthur, Buckland, Copping, the Steppes and the Midlands. Most of these occurrences belong to the upper portions of the sequence, generally the Lindisfarne Stage, and outcrop beneath Mesozoic Sandstones which cap the hills.

2. NORTHERN DIVISION.

i. *Mersey District.*

Owing to the paucity of outcrops in this district, most of the information relating to the Kamilaroi succession has been obtained, of necessity, from bore cores or mine workings.

The beds consist of basal glacial conglomerates which pass upwards without any well-marked break into marine sandstones and mudstones containing numerous fossil shells. The deposition of marine sediments was interrupted in certain areas by a change to fresh-water conditions, resulting in the formation of the Mersey Coal Measures. Elsewhere the coal horizon is represented by an oil shale known as Tasmanite.

The succession may be considered in four stages as follows (in descending order):

	Thickness (feet).
KAMILAROI SYSTEM.	
(*d*) Upper Latrobe Stage.	
Marine sandstones and mudstones containing *Fenestella, Dielasma, Spirifer tasmaniensis, Eurydesma cordatum, Eurydesma hobartense* and *Keeneia twelvetreesi*. .. .. More than	1,000
(*c*) Mersey Coal Measures, or Tasmanite Stage. .. .. About	200
Mersey Coal Measures.	
Fresh-water mudstones, shales and sandstones with occasional conglomerates and two coal-seams. The lower or Mersey Seam is the more persistent and averages 18 inches in thickness. Plant fossils include: *Glossopteris Browniana* Brongn., *G. ampla* Dana, *G. indica* Schimper, *Gangamopteris angustifolia* McCoy, *G. cyclopteroides* Feistmantel, *Noeggerathiopsis Hislopi* Bunbury, *Phyllotheca australis, Cardiocarpus* sp. Thureau recorded the remains of an amphibian, probably a Labyrinthodont (Twelvetrees, 1912).	
Tasmanite Beds.	
Marine fossiliferous sandstones and mudstones with a 3-feet to 6-feet seam of tasmanite, an oil-shale containing resinous spore-cases of a supposed lycopodiaceous plant termed by Professor Newton of the British Museum *Tasmanite punctatus* (Reid, 1924, p. 36). The tasmanite is regarded as occupying approximately the same horizon as the Mersey Coal seam. Marine fossils include *Spirifer tasmaniensis, Aviculopecten sprenti, Deltopecten fittoni, Deltopecten subquinquelineatus, Cardiomorpha gryphioides, Pleurotomaria morrisiana*.	
(*b*) Lower Latrobe Stage.	
Marine conglomerates, pebbly sandstones, sandstones and mudstones containing *Fenestella plebeia, Stenopora tasmaniensis, Spirifer tasmaniensis, Pleurotomaria morrisiana* and, almost certainly, *Eurydesma cordatum*.	600
(*a*) Basal Glacial Stage.	
Conglomerates and sandstones containing angular fragments of quartzites, sandstones, granites and gneisses. Some glacial pebbles are excellently faceted and striated. No fossils recorded. .. .. About	150
Hiatus and unconformity.	
SILURIAN AND CAMBRO-ORDOVICIAN.	

A study of the sections based on bore-cores (Reid, 1924) suggests that beds belonging to the Lower Latrobe Stage in some areas overlap the Basal Glacial Stage. This is probably due to the fact that the sediments were laid down upon an uneven surface.

The presence of fresh-water beds, the Mersey Coal Measures, among marine strata does not necessarily prove a hiatus of any magnitude. The apparent contemporaneous continuity of deposition of marine sediments in adjacent tasmanite-bearing areas is some evidence against such a time-break. On the other hand, it is admitted that outcrops are so poor that, even if a disconformable relationship existed between any of the beds, its detection would be most unlikely.

In spite of the economic importance of the coal and tasmanite beds and the considerable work done on them, geological knowledge of the series as a whole is so incomplete that it is difficult to come to any definite conclusions as to the correct sequence of the various units.

ii. *Lilydale–Karoola.*

Essentially the same stages as those described for the Mersey District occur at Lilydale, Karoola and Mount Arthur. Exposures, however, are much better.

	Maximum thickness (feet).
Later beds removed by erosion.	
KAMILAROI SYSTEM.	
(*d*) Upper Latrobe Stage.	
Not visible in sections directly above the Tasmanite Stage, but recorded from the district by Nye (1924*a*). Thinly-bedded friable mudstones and shales containing small amounts of rounded pebbles and occasional marine fossils. .. .. At least	300
(*c*) Tasmanite Stage.	
Basal, fine to medium-grained sandstones with some coarser grits. Numerous remains of *Glossopteris* in some localities. The sandstones are overlain by mudstones which, at Karoola, contain a band of oil-shale or tasmanite.	150
(*b*) Lower Latrobe Stage.	
Sandstones and mudstones with a fine-grained, dark-blue limestone band several feet thick. The limestone is a *Eurydesma cordatum* zone. It contains also the foraminifera (Howchin, 1893) *Nubecularia lucifuga*, var. *stephensi*,* *Spiroloculina? planulata*, *?Cornuspira involvens*, *Nodosaria* (?) *radicula*, numerous bryozoa, and the marine shells *Productus brachythaerus*, *Spirifer duodecimcostata*, *Reticularia*, *Deltopecten limaeformis*, *Stutchburia costatus*, *Merismopteria macroptera*, *Eurydesma hobartense*, *Platyschisma oculum* and *Ptychomphalina*. .. .. More than	150
(*a*) Basal Glacial Stage.	
Conglomerates passing up into sandstones and mudstones and containing erratic boulders of quartz, quartzites and slates, possibly of local origin, and granites, gneisses, schists and quartzites from distant sources. Occasional pebbles show faceting, polishing and grooving, denoting glacial origin.	100
Hiatus and unconformity.	
CAMBRO-ORDOVICIAN.	

iii. *Beaconsfield.*

Kamilaroi rocks cover a large portion of the country between the Mersey and Tamar rivers and are exposed near Beaconsfield, Winkleigh, Flowery Gully and Middle Arm Creek. The Basal Glacial and Lower Latrobe Stages are present, but neither coal nor tasmanite has been found. It is assumed that the beds above the Lower Latrobe Stage have been removed by erosion, but Nye (1924*b*) recognized the possibility of the fresh-water stage being represented by sandstones without any development of the carbonaceous deposits. Hence, it is possible that members of the Mersey Coal Measures, Tasmanite Stage or Upper Latrobe Stage will be identified later.

	Maximum thickness (feet).
KAMILAROI SYSTEM.	
(*b*) Lower Latrobe Stage.	
Highly fossiliferous mudstone with sandstone and some limestone. At Middle Arm Creek Johnston (1888) recognized two zones which were scarcely separable from one another:	
(1) Upper or Fenestella Zone, containing an abundance of *Fenestella internata*, *F. plebeia*, *Protoretepora ampla*, *Stenopora tasmaniensis*, *Dielasma sacculum*, and *Spirifer crebristria*.	
(2) Lower or Eurydesma Zone, containing the limestone bands and characterized by *Eurydesma cordatum*, *E. gigas*, and also *Dielasma sacculum*, *Productus scabriculus*, *Spirifer tasmaniensis*, *S. duodecimcostata*, *Aviculopecten sprenti*, *Deltopecten limaeformis*, *D. subquinquelineatus*, *Astartila polita*, *Pleurotomaria morrisiana* and *Platyschisma oculum*. There is little doubt that the limestone	

* Miss I. Crespin states that this is now included in the genus *Calcitornella*.

	Maximum thickness (feet).
in this zone corresponds with the limestone horizon which contains *Eurydesma cordatum* in the adjacent Lilydale District. .. .. About	700
(*a*) Basal Glacial Stage. Conglomerates consisting of numerous water-worn pebbles of hard rock types in a sandy matrix. Pebbles are generally well rounded, some show faceting but no grooving.	100

Hiatus and unconformity.

CAMBRO-ORDIVICIAN AND SILURIAN.

iv. *Western Tiers.*

Kamilaroi rocks outcrop round the northern and eastern margins of the Western Tiers and are disconformably overlain by Mesozoic sediments. Between the Tiers and the coast they are covered generally by Tertiary basalts and Recent deposits, but they outcrop on the banks of the River Meander near Cheshunt, in the Dunorlan District, Kimberley, and in the Quamby Brook near Quamby Bluff.

The Cheshunt beds contain *Productus brachythaerus, Dielasma sacculum, Spirifer tasmaniensis, Spirifer duodecimcostata, Eurydesma cordatum, Merismopteria macroptera, Deltopecten limaeformis, Platyschisma oculum* and *Pleurotomaria morrisiana* (Johnston, 1888). They probably can be assigned to the Lower Latrobe Stage.

Oil-shale at Quamby Bluff indicates the presence of the Tasmanite Stage. It is overlain by 300 feet of dark-grey mudstones, part of which might well be referred to the Upper Latrobe Stage. The topmost beds of the sequence are "barren yellow mudstones", lithologically comparable with those of the Lindisfarne Stage in the Southern Division. As the beds may be traced round the Tiers this correlation may be regarded as reasonably sound.

The section may be summarized as follows:

TRIASSIC SYSTEM.

Hiatus and disconformity.

KAMILAROI SYSTEM.

(*e*) Lindisfarne Stage.
(*d*) Upper Latrobe Stage.
(*c*) Tasmanite Stage.
(*b*) Lower Latrobe Stage.

The basal beds are not exposed and the thickness of the section has not been measured.

v. *Wynyard and Preolenna.*

This area is well known because of the wonderful development of glacial beds which have been described in detail by Professor T. W. E. David (1907). In the Preolenna District these are overlain by marine and fresh-water deposits (Hills, 1913). Exposures inland are scarce owing to the presence of thick horizontal scrub in the valleys and Tertiary basalt on the hills.

The stages into which the sequence has been divided may correspond with those in the Mersey District, but, as no reliance can be placed on a correlation between fresh-water phases, different stage names have been adopted. A section based upon that compiled by Hills (1913) follows:

	Maximum thickness (feet).
Section interrupted by intrusive dolerite.	
(*d*) Flowerdale Stage. (ii) Yellow to reddish-brown unfossiliferous sandstones which may possibly be Mesozoic.	550

	Maximum thickness (feet).
(i) Sandstone, pebbly sandstone and mudstone with marine bryozoa and brachiopods.	50
(*c*) Preolenna Coal Measures.	
Coarse-grained yellowish-brown sandstones between which are finer-grained rocks carrying coal-seams and carbonaceous material. Indeterminate plant remains.	140
(*b*) Inglis Stage.	
(ii) Grey marine mudstones containing *Fenestella, Spirifer tasmaniensis, Productus, Eurydesma* and *Aviculopecten*.	140
(i) Blue-grey unfossiliferous mudstone and conglomeratic mudstone. .. .. More than	300
(*a*) Wynyard Glacial Stage.	
Glacial till; conglomerates frequently containing erratics and striated boulders; thinly-bedded but minutely-laminated clay-shales, with intercalated thin flaggy sandstones and occasionally thin bands, 1 to 2 inches only, of boulder-clay. The sandstones and mudstones are, in many cases, beautifully ripple-marked. .. .. More than	1,220
Hiatus and unconformity.	
SILURIAN, CAMBRO-ORDOVICIAN OR PRE-CAMBRIAN.	

In the "Coal Resources of Tasmania" (Tas. Geol. Surv., 1922) a change was made in connection with the age and stratigraphical position of some of the Preolenna coal-seams. It was stated that: "In previous reports it has been impossible to decide whether these upper coal seams belong to the Permo-Carboniferous or the Trias-Jura as no fossil evidence was available. Their classification as belonging to Tomago is based on the recent discovery at Mount Pelion of an undoubted *Glossopteris* in shales associated with the coal at an exactly corresponding horizon as these upper coals at Preolenna."

The writer cannot accept this argument on the grounds that: (1) the discovery of *Glossopteris* at Mount Pelion does not indicate the age of the Preolenna beds unless adequate evidence for correlation is available; (2) in view of the fact that the stratigraphical position of the Preolenna coal-seams is uncertain, the statement that the coal at Mount Pelion is on "an exactly corresponding horizon" lacks foundation; and (3) no convincing evidence has been produced to demonstrate that the Mount Pelion Coal Measures correspond to the Tomago Series of New South Wales or, indeed, to any high horizon in the Kamilaroi System.

While there is a possibility that the reddish-brown sandstones placed at the top of the Flowerdale Stage might be Mesozoic, any associated coal-seams could belong to this group. On the other hand, it is more probable that faulting has placed the seams belonging to the Preolenna Coal Measures in anomalous positions. At all events, details of the occurrences of the seams are so vague that no definite conclusion can be reached.

3. WESTERN DIVISION.

i. *Mount Pelion, Barn Bluff, Cradle Mountain, Eldon and Du Cane Ranges.*

Kamilaroi rocks cover a large area in this district, but have not been examined in detail. In the neighbourhood of Mount Pelion and Barn Bluff the sequence may be divided into three stages. Sills of intrusive dolerite interrupt the succession.

	Thickness (feet).
KAMILAROI SYSTEM.	
(*c*) Mount Pelion Coal Measures.	
(ii) Sandstones with quartz pebbles in beds near the base. More than	300

	Thickness (feet).
(i) Sandstones and finely-laminated carbonaceous sandy shales containing three workable seams of coal. Plant remains include *Glossopteris ovata*? and *Noeggerathiopsis*. .. .. About	30
(*b*) Achilles Stage. .. .. About	700
(ii) Grey mudstones and shales weathering yellow, associated with rich marine fauna, including *Fenestella, Protoretepora ampla, Stenopora, Spirifer, Productus* and *Aviculopecten*.	
(i) Bluish-grey unfossiliferous mudstones.	
(*a*) Basal Glacial Stage. .. .. About	150
(ii) Pelionite Horizon. Developed at Barn Bluff and consisting of two feet of cannel coal known as "Pelionite" enclosed in black micaceous shale, sandstone and conglomerate.	
(i) Conglomerate and glacial till passing upwards into pebbly sandstones and mudstones.	

Hiatus and unconformity.

SILURIAN.

Although the Pelionite Horizon had been correlated with the Mersey Coal Measures (Tas. Geol. Surv., 1922), it is regarded here as just one phase of the Basal Glacial Stage. A similar carbonaceous deposit occurs in the St. Mary's District at the top of the St. Mary's Basal Stage.

No pelionite has been found at Mount Pelion itself.

Reid (1919) stated: "The southerly dip of the basin is apparent from an examination of the western slope of the Oakleigh Range; the quartz schist bedrock rises to the north and the coal measure strata between it and the overlying diabase (dolerite) become thinner and thinner in that direction until they entirely disappear."

In view of the observed fact that the dolerite has not been injected strictly parallel to the bedding of the Kamilaroi rocks, but is transgressive, intruding mudstones at Barn Bluff, sandstones at the south end of Cradle Mountain and conglomerates at the north end, the varying thickness of strata between bedrock and dolerite has little significance. Moreover, the southerly dip could be attributed to tilting of the basement rock during the Tertiary block-faulting movements.

ii. *Henty River.*

Marine and fresh-water rocks outcrop between Malanna and Strahan and along the northern side of the Henty River. Johnston (1891) correlated the marine beds with those round the base of East Pelion and Mount Pelion and the fresh-water beds with the overlying Mount Pelion coal measures.

KAMILAROI SYSTEM.

(*c*) Mount Pelion Coal Measures (?).
Hard fissile dark-grey shales with curious botryoidal concretions. Beautifully preserved plant fossils include *Glossopteris Browniana, Gangamopteris spatulata, Gangamopteris obliqua,* and *Noeggerathiopsis media.*

(*b*) Achilles Stage (?).
Fossiliferous marine mudstones and impure limestones characterized by *Fenestella internata, Fenestella plebeia, Protoretepora ampla, Stenopora tasmaniensis, Spirifer tasmaniensis, Spirifer avicula, Spirifer convoluta* and *Chaenomya etheridgei.*

There is no record of the underlying beds.

iii. *Central Plateau.*

Patches of Kamilaroi rocks occur over the Central Plateau and may be seen in all of the many gorges cutting into its flanks, e.g. the Ouse Valley at Waddamanna, and predominate everywhere below the 1,500 ft. contour (Lewis, 1932). The succession is interrupted by dolerite and little is known of the sequence.

The Lindisfarne Stage has been recognized in numerous places, such as the Steppes near Bothwell, while Johnston (1888, p. 128) recorded the presence of massive fossiliferous limestone with slaty rocks at Marlborough. Marine fossils found at the last-named locality include *Fenestella internata, Protoretepora ampla,* Crinoid stems, *Productus brachythaerus, Spirifer glaber* and *Spirifer stokesi.*

iv. *Point Hibbs.*

Loftus Hills (1914) described marine beds containing the usual Kamilaroi fossils from Point Hibbs on the West Coast. These rocks are associated with conglomeratic mudstones containing boulders of granites, porphyries and greisens, up to a foot in diameter. These sediments are intruded by dolerite and are tilted at high angles near the contact.

4. EASTERN DIVISION.

Within this division the Kamilaroi succession is remarkably consistent and correlation throughout is straightforward. It may be divided conveniently into two stages.

MESOZOIC GROUP.

Hiatus and disconformity.

KAMILAROI SYSTEM.

(*b*) Gray Stage.

(*a*) St. Mary's Basal Stage.

Hiatus and unconformity.

CAMBRO-ORDOVICIAN ROCKS OR GRANITE.

i. *St. Mary's District.*

Excellent exposures occur in the neighbourhood of the village of Gray, about three miles east of St. Mary's.

	Thickness (feet).
(*b*) Gray Stage.	
Sandstones, shales, bryozoan mudstones and light grey crinoidal limestones. Marine fossils include: *Plerophyllum cainodon, Fenestella* spp., *Protoretepora ampla, Stenopora* sp., *Stenopora tasmaniensis,* Crinoid stems, *Wyndhamia dalwoodensis, Terrakea fragile, Spirifer strzelecki, S. vespertilio, S. tasmaniensis, S. duodecimcostata, S. oviformis, S. stokesi, Martiniopsis oviformis, M. subradiata, Aviculopecten sprenti, Astartila* sp., *Ptychomphalina morrisiana.* .. .. About	250
(*a*) St. Mary's Basal Stage.	
(ii) Mount Elephant Coal Horizon. One or two coal seams in sandstones. Unidentified plant stems.	
(i) Water-sorted conglomerates of various degrees of coarseness. These pass up through coarse quartz-grits into normal quartz-sandstones. .. .. About	100

ii. *Avoca, Fingal, etc.*

Beds of similar character to those described above outcrop in various places in the Avoca, Fingal and Mount Nicholas districts (Nye, 1921–26; Tasmanian Geological Survey, 1922).

iii. *Dalmayne.*

The total thickness of the Kamilaroi System here is about 370 feet, comprising 170 feet belonging to the St. Mary's Basal Stage and 200 feet to the Gray Stage. Only 30 feet of strata intervene between the limestone unit and the overlying Mesozoic rocks (Nye, 1926).

iv. *Picanini Creek.*

An apparent thickness of 400 feet of limestone overlies the St. Mary's Basal Stage which rests unconformably upon slates at an altitude of 100 feet above sea-level. The limestone is probably duplicated by faulting and may be much thinner (Tas. Geol. Surv., 1922, p. 54).

v. *Seymour.*

No. 4 bore at Seymour passed through Mesozoic strata into Kamilaroi rocks. The section below the last coal-seam follows:

	Thickness. ft.	ins.	(Approx. position.) Depth. ft.	ins.
MESOZOIC GROUP.				
Hiatus and disconformity.				
KAMILAROI SYSTEM.				
(*b*) Gray Stage.				
Mudstones, no traces of coal	20	1½	385	2½
Mudstone, minute fossils	77	6½	462	9
Green sandstone with pebbles	22	10	485	7
Limestone (fossils)	9	9	495	4
Silicified limestone (?)	0	10	496	2
Hard limestone (fossils)	123	3	619	5
Blue limestone	125	10	745	3
Fine-grained sandstone	42	8½	787	11½
(*a*) St. Mary's Basal Stage.				
Shale, sandstone and conglomerate	16	8½	804	8
Shale and conglomerate	2	3	806	11
Coarse-grained sandstone, few coal markings	9	6	816	5
Very coarse sandstone, patches of conglomerate, no coal marks	20	10½	837	3½
Conglomerate and rotten granite boulders	54	11½	892	2

This makes the total thickness of the beds more than 500 feet, the St. Mary's Basal Stage making up 100 feet and the Gray Stage just over 400 feet.

vi. *Llandaff.*

Several outcrops of Kamilaroi rocks, including the limestone, occur around Llandaff. The beds are similar to those in the St. Mary's District (Twelvetrees, 1901; Tas. Geol. Surv., 1922, p. 84).

vii. *Mount Peter and Mount Paul.*

In this district the St. Mary's Basal Stage is represented by the usual conglomerates and sandstones. The limestone of the Gray Stage follows and, in the eastern part of the area, extends to the tops of the hills. It is overlain by Mesozoic grits immediately to the north-west of Mount Paul.

A specimen of *Eurydesma globosum* was found on the east side of Mount Peter.

PALAEONTOLOGY.

General Remarks.

Since Johnston described his Tasmanian fossils last century many alterations have been made in their names and classification. One important change has been made in connection with the lamellibranch called by Johnston *Pachydomus hobartensis*, which is known now as *Eurydesma hobartense*. Hence, when quoting from Johnston's work the present writer has taken the liberty of using the more modern designations.

Little use has been made of the fossils quoted by Johnston (1888) because he did not list them under localities but under serial names. This might not have been so unfortunate had he not included in his "Lower Marine Series" several collections from horizons now more satisfactorily correlated with those which he

regarded as belonging to the "Upper Marine Series", e.g., Bruny Island, Eaglehawk Neck, and Buckland. He, and others, were deceived by certain glacial beds thought to occur at the base of the "Lower Marine Series", but later proved to belong to the Woodbridge Glacial Stage much higher in the sequence. As there is little, if any, difference between the fauna of Johnston's "Upper Marine" and "Lower Marine" series he did not possess any information to make him think otherwise.

With a few exceptions, the fossils listed in this section were collected by the writer and were identified by Mr. H. O. Fletcher of the Australian Museum. While such lists are not nearly so complete as those of Johnston, they are more reliable in the light of our present knowledge. Localities, as well as the suggested stratigraphical positions, have been given and this will permit the use of these lists in the event of any further attempt to interpret the sequence. The specimens are catalogued and housed in the Australian Museum, Sydney.

With regard to the fossils, Fletcher states: "The fauna is one that is almost essentially Upper Marine in character, practically every species represented having been recorded either from the South Coast or Branxton beds of Eastern Australia. The large numbers of *Eurydesma*, however, from several of the Tasmanian localities mark those beds as being low in the Permian sequence. *Aviculopecten mitchelli* Eth. & Dun, usually considered as being typical of the Lower Marine Series, has been collected from the Upper Marine beds, so that its appearance here is of no significance. It is interesting to note that *Wyndhamia dalwoodensis* of Booker is present in the Grange Stage in beds with abundant *Fenestella*, an association similar to Branxton which is the type area of *Wyndhamia*. *Eurydesma cordatum* has recently been discovered in the Branxton beds where it is not uncommon, but *Eurydesma cordatum* var. *sacculum* Dana is still typical of the Lower Marine Series.

"The faunas of each locality where collections were made in the Tasmanian Permian are essentially the same, being characterized by an abundance of *Spirifer tasmaniensis* Morris, *Spirifer duodecimcostata* McCoy and *Fenestella*. It would appear from this that in Tasmania we could possibly be dealing with Permian beds with no great vertical extent, or a sequence laid down under conditions which did not materially alter."

It is the writer's belief that the Tasmanian upper Palaeozoic beds are scattered throughout nearly the whole time interval represented by the Kamilaroi System. That is to say that both Lower and Upper Marine beds are represented. Such a belief is based on the following points:

i. The Lower Marine age of certain beds appears to be proved by the presence of a basal glacial stage corresponding in position to the Lochinvar beds of New South Wales, the Talchir beds of India, and the Dwyka beds of South Africa and the occurrence not far above this of a *Eurydesma* horizon recognized also in New South Wales, India and South Africa.

ii. The Upper Marine age of some of the beds is indicated by Fletcher's remarks on the fauna. The lithology of these beds is consistent with an Upper Marine age as it is similar to that of the New South Wales beds.

iii. The Woodbridge Glacial Stage high in the sequence might well be correlated with the Upper Marine glacial beds of New South Wales.

While the evidence is not conclusive, there is at least some support for the view expressed by Cowper Reed (1932) and Raggatt and Fletcher (1937) that it is not possible to distinguish between beds corresponding respectively to the Lower and Upper Marine beds of New South Wales on palaeontological evidence alone. Further, as noted above, Johnston (1888), an authority on the Tasmanian fauna, mixed his own Lower and Upper Marine localities. It is impossible, therefore, to accept previous correlations based on faunal evidence.

List of Fossil Localities.

	Granton Stage.				Grange Stage.				Woodbridge Glacial Stage.			Other Stages.			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Plerophyllum cainodon De Kon.												Sp.			X
Fenestella fossula Lons. ..	X	X	X	X	X	X	X	X		X	X	X	X	X	X
F. internata Lons. ..	X	X	X	X	X	X	X	X		X	X	X	X	X	X
Protoretepora ampla Lons. ..	X	X	X	X		X	X	X							X
Stenopora crinita Lons. ..	Sp.							X			X				Sp.
S. tasmaniensis Lons. ..		X	X	X	X		X	X				X	X	X	X
Crinoid stems		X	X										X	X	X
Chonetes sp.		X	X		X										
Dielasma sp. indet.		X	X		X	X	X							X	
Strophalosia clarkei Eth. ..	Cf.														
	X			Sp.		X		X					X		
S. gerardi King															
S. cf. *jukesi* Eth. fil. ..		X				X	X								
Terrakea brachythaera Sowerby		X				X						X			
T. elongata Eth. fil.		X				X									
T. fragile Dana							X					X		X	X
Wyndhamia dalwoodensis Booker		X	X				X					X			X
Spirifer convolutus Phill. ..								X		X				X	
S. duodecimcostata McCoy ..	X	X	X	X	X	X	X	X		X		X	X	X	X
S. stokesi Konig.				X											
S. strzelecki De Kon. ..		X			X										X
S. tasmaniensis Morris ..		X		X		X	X	X					X	X	X
S. vespertilio		X		X	X		X	X	X						X
Taeniothaerus subquadratus (Morris)		X													
Martiniopsis oviformis ..		X	X	X	X	X	X		X					X	X
M. subradiata Sowerby ..		X	X	X	X	X	X	X	X					X	X
M. subradiata var. *branxtonensis* Eth. fil.						X								X	
Astartila sp.		X							X			X		X	X
? *Edmondia nobilissima* De Kon.				X					Sp.				Sp.		
? *Chaenomya etheridgei* De Kon.				X						X					
Myonia carinata (Morris) ..													X		
M. elongata Dana							X								
Notomya sp.				X											
Merismopteria macroptera (Morris)													X		
Modiomorpha ornatissima Johnston								X							
Stutchburia compressa (Morris)				X										X	
Eurydesma cordatum Morris ..	X			X									X	X	
E. cordatum var. *sacculum* Dana	X														
E. hobartense Johnston ..	X												X		
Deltopecten fittoni (Morris) ..	X			X											
D. leniusculus Dana							X								
D. limaeformis (Morris) ..	X	X										X	X	X	
D. subquinquelineatus (McCoy)		X			X										
Aviculopecten englehardti (Eth. & Dun)		X		X											
A. mitchelli (Eth. & Dun) ..		X					X								
A. multicostatus Fletcher ..															
A. sprenti Johnston ..		X				X	X					X		X	
A. squamuliferus (Morris) ..		X				X	X								
A. tenuicollis (Dana) ..	X														
Platyschisma oculus Sowerby				X	X	X		X	X			X		X	
Ptychomphalina morrisiana McCoy		X	X	X	X	X	X			X		X	X		X
Hyolithes sp.									X						

Correlations within Tasmania.

While it is reasonable to assume that the basal glacial beds throughout Tasmania are contemporaneous, the differences in lithology and thickness from place to place introduce a certain element of doubt. The variable thickness is in part due to the undulating surface upon which they were laid down, but at Wynyard the great thickness, exceeding 1,200 feet, can hardly be explained in this way. The whole deposit differs greatly from the glacial beds elsewhere and was thought by David (1932) to be older. However, there is no evidence available to determine this point.

Up to the present the St. Mary's Basal Stage has not shown any definite evidence of glacial origin, the beds being ordinary water-sorted quartz-pebble conglomerates and sandstones. The presence of the Mount Elephant Coal Horizon at Barn Bluff forms a link between these two areas. Reid (1919) described the Mount Pelion basal beds as tillite in part. The association of coal beds with them, as well as at St. Mary's, suggests that the basal beds in the Western and Eastern Divisions were laid down under terrestrial conditions.

For the purposes of correlation outside Tasmania the contemporaneity of all the basal glacial beds will be accepted tentatively.

The rich *Eurydesma* zone occurring slightly above the glacial beds provides a good datum horizon within Tasmania at least. It has been found in the Granton Stage at Maria Island, in the same stage on the Glen Lusk road near Berriedale, in the Lower Latrobe Stage at Lilydale, Karoola and Beaconsfield, and might be expected to occur in the Inglis Stage at Preolenna and the Achilles Stage in the Mount Pelion region.

With the exception of the Eastern Division, the lowest beds in the Kamilaroi System correspond quite well throughout the island if due allowance is made for change in facies. Difficulties arise as soon as the fresh-water beds are considered. In the Mersey District these appear to be quite low down in the sequence. Though they are not regarded as such important index fossils as they were, the occurrence of both *Eurydesma cordatum* and *Eurydesma hobartense* among the few fossils found in beds overlying the Mersey Coal Measures at least indicates a Lower Marine age for the Upper and Lower Latrobe Series and for the Mersey Coal Measures.

A study of the bore-cores (Reid, 1924) shows that the tasmanite bed approaches very close to the base of the series in some places, even though in others the sub-tasmanite beds attain a thickness of six or seven hundred feet. At Karoola the tasmanite is only a very small distance above the main *Eurydesma* horizon.

Unconvincing though the arguments cited above may seem, they carry more weight than the correlation which has been accepted in the past between the Mersey Coal Measures and the Porter's Hill Stage merely on the evidence of a few fragments of *Gangamopteris* in the latter.

Granton Stage: 1. Below Berriedale Limestone on Glen Lusk Road; 2. Berriedale Limestone at Collinsvale Lime kilns; 3. Berriedale Limestone at Granton; 4. Sandy Bay Beds below Porter's Hill stage.

Grange Stage: 5. Grange Quarry; 6. Mount Wellington just above old water reserve; 7. Mount Faulkner just below Lindisfarne Stage, near Sky Farm; 8. Cape Paul Lamanon below Woodbridge Glacial Stage.

Woodbridge Stage: 9. Lindisfarne rock platforms along Derwent Estuary; 10. Cape Paul Lamanon; 11. Eaglehawk Neck.

Lindisfarne Stage: 12. Eaglehawk Neck.

Lower Latrobe Stage: 13. Lilydale; 14. Karoola.

Gray Stage: 15. Gray.

As fresh-water horizons are quite common throughout Kamilaroi sequences, not only in Australia but in other parts of the world, they cannot always be regarded as datum horizons. It is not safe to correlate the Mersey Coal Measures with the Preolenna or Mount Pelion Coal Measures because no evidence can be produced to favour this. On the contrary, the Mersey Coal Measures are limited in geographical extent and pass into the marine beds of the Tasmanite Stage. Even the correlation of the Mersey Coal Measures with the Pelionite Horizon has been advocated (Tas. Geol. Surv., 1922). The writer is opposed to loose correlations between coal seams which happen to be the first fresh-water deposits developed in the respective sequences. It is unfortunate, too, that the palaeontological evidence is insufficient to disprove such correlations when once they have been made. All that can be done now is to point out that such correlations have been made in order to fit the various sequences into pre-conceived subdivisions, viz., Lower Marine, Greta, Upper Marine, etc. The stratigrapher may then judge whether any weight should be attached to them. The present writer prefers to assume that all the Coal Measures are on slightly different horizons.

In view of what has been stated above, there does not seem to be anything to recommend a correlation between any of the above beds and the Greta Coal Measures of New South Wales, more than seven hundred miles away.

The Gray Stage in the Eastern Division possesses only one distinctive feature which may be of use in correlating it with any other Kamilaroi sequence. This is the crinoidal limestone which may correspond with the Crinoidal Zone of the Granton Stage at Maria Island. In both cases crinoid remains are extraordinarily abundant, whereas they are comparatively rare elsewhere in Tasmania. The whole of the sequence in the Eastern Division differs considerably from that in the other divisions. It is more completely known because of bore records, good exposures, and in view of the fact that the units from the basal conglomerates which rest unconformably upon older rocks right to the base of the Mesozoic beds can be readily examined. Apart from the point mentioned above, there does not appear to be any means of telling whether the Gray Stage can be referred to the Upper Marine or Lower Marine Series of New South Wales. This is another matter which remains unsolved.

The Grange Stage has not been identified outside the Southern Division, but there it is characterized by *Wyndhamia dalwoodensis*. Like *Eurydesma cordatum*, this shell is not restricted to the stage in which it has its maximum development, but it is useful nevertheless in determining the beds belonging to this stage.

The Woodbridge Glacial Stage is an important stratigraphical horizon which enables a correlation to be made between many areas in the Southern Division. Hardly less distinctive are the "barren yellow mudstones" of the Lindisfarne Stage. These are recognizable over a large part of Tasmania from the Western Tiers to Hobart.

The Cygnet Coal Measures are the highest beds in the Kamilaroi sequence, but appear to be restricted in their development to the area south of Hobart.

The above interpretation of possible correlations differs from that which has been accepted by Tasmanian geologists up to the present time, in that the New South Wales terms have not been used.

The following list shows which of the stages defined by the writer would have been included in the Upper and Lower Marine Series, etc., by previous workers who used the New South Wales classification. The list has been compiled principally from the views expressed in the report on the coal resources of Tasmania made by the Geological Survey Staff in 1922. Allowance has been made for

information which has been obtained since the report was published. The principal addition is the Woodbridge Glacial Stage.

Upper Coal Measures: Cygnet Coal Measures; Higher Preolenna Coal Measures; Mt. Pelion Coal Measures.

Upper Marine Series: Lindisfarne Stage; Woodbridge Glacial Stage; Grange Stage; Upper Latrobe Stage; Flowerdale Stage; Achilles Stage; Gray Stage.

Lower Coal Measures: Porter's Hill Stage; Mersey Coal Measures; Tasmanite Stage; Preolenna Coal Measures; Pelionite horizon; Mount Elephant Coal Horizon.

Lower Marine Series: Granton Stage; Lower Latrobe Stage; Inglis Stage; Basal Glacial Stages; Wynyard Glacial Stage; St. Mary's Basal Stage.

The accompanying diagram (Fig. 2) shows some generalized Tasmanian Kamilaroi sections and illustrates the difficulties experienced in attempting correlations.

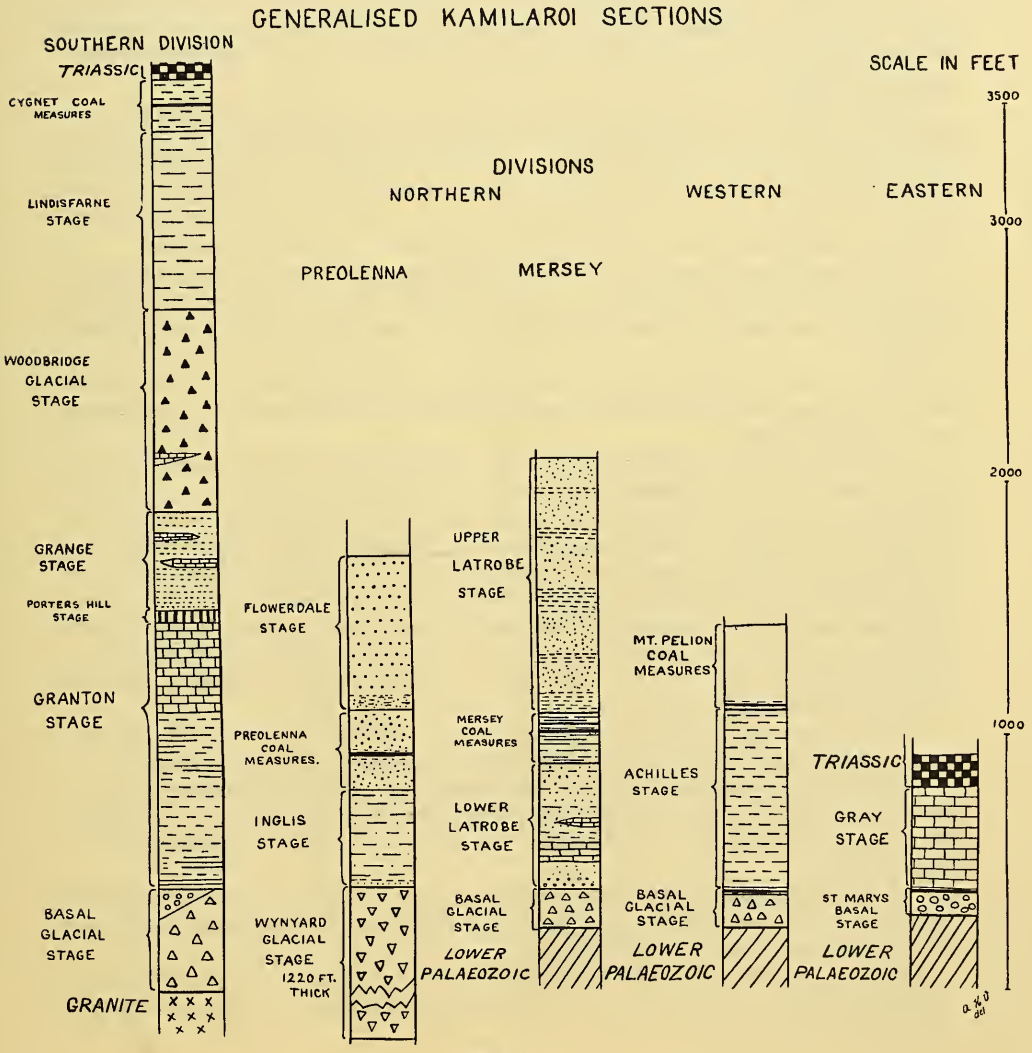

Fig. 2.

Correlations with New South Wales.

There is no doubt that all of the Upper Palaeozoic rocks of Tasmania belong to the Kamilaroi System and that they may be correlated broadly with the type sections in the Hunter River District of New South Wales.

Each sequence is characterized by a basal glacial stage followed much later by a second. Correlation between the higher stages is less certain than between the lower ones. A well-marked *Eurydesma* zone occurs low down in each section and is associated with a rich marine fauna. The similarity between the flora and fauna and their remarkable uniformity throughout the system have already been discussed. *Glossopteris* and *Gangamopteris* are the common plants, while *Fenestella, Stenopora, Spirifer tasmaniensis, Wyndhamia dalwoodensis,* the Pectens, *Ptychomphalina morrisiana* and many other marine fossils are abundant in both areas.

In making any more detailed correlation than the above, it must be remembered that the two areas are more than 700 miles apart and there is reason to believe that much of the region now known as Victoria was a land-mass during Kamilaroi times.

Most workers will concede that the Basal Glacial Stage of the Tasmanian sequence might well correspond with the Lochinvar Glacial Stage of the Lower Marine Series of New South Wales. On the other hand, it has already been pointed out that there is no certainty that the Wynyard Glacial Stage and the St. Mary's Basal Stage are contemporaneous with the Basal Glacial Stage elsewhere in Tasmania. Thus there must remain some doubt about this point.

The *Eurydesma* horizon occurs in the Granton and Lower Latrobe Stages of Tasmania and might be expected in the Inglis and Achilles Stages, so portions of each of these should correspond with the Allandale Stage of the Lower Marine Series.

In New South Wales the Greta Coal Measures follow the Lower Marine Series and in the past the Mersey Coal Measures and Porter's Hill Stage were correlated with these measures.

As noted in the preceding section, the writer cannot see any justification for the correlation of the Mersey, Preolenna and Porter's Hill Stages even within Tasmania. Hence the correlation of any of these beds with the Greta Coal Measures is unsound. Under the circumstances the dividing line between the "Lower Marine Series" and "Upper Marine Series" in Tasmania under the old scheme could not be recognized in areas where plant beds were not developed, and, as in the case of the Porter's Hill section, workers were inclined to accept any leaf-bed, no matter how indefinite, in order to provide a "Greta Series" separating the marine beds, e.g., Porter's Hill Stage, Johnston (1888), Pelionite Horizon (Tas. Geol. Surv., 1922).

The writer also is unable to separate "Lower Marine" from "Upper Marine" beds in Tasmania and has used new stage names in order to avoid the issue.

The fauna of the Grange Stage is comparable with that of the Branxton Stage of the Hunter River, and, coupled with the presence of the Woodbridge Glacial Stage immediately above, this is indicative of the Upper Marine Series of New South Wales.

In their stratigraphical position only, at the top of the succession, the Cygnet Coal Measures correspond to the Upper Coal Measures of New South Wales, but no more exact correlation can be made.

Raggatt and Fletcher (1937) have discussed the correlation of the New South Wales Kamilaroi beds with other extra-Australian areas and their views are acceptable to the writer.

Conclusion.

An attempt has been made to summarize the position with regard to the Tasmanian Upper Palaeozoic rocks, to draw attention to the weaknesses in earlier classifications, and to suggest stage names which could be used as a basis for further work.

It is hoped that this paper has done something to clarify the position with regard to this interesting area.

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